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ABSTRACT

This is a longitudinal study of a child's acquisition of Mandarin phonology between the ages of 1;2 and 2;8. During this period, the child was much less verbal than many children reported in other child phonology studies. The study consists of two parts. The first part is a description of the child's "proto-langauge," in which he used sound-meaning correspondences of his own invention for communicative purposes. It was found that both the segmental forms and the pitch contours of different "proto-words" correlated with their communicative functions. The second part deals with the child's phonological development following the switch to words based on adult models. Although the child produced very little spontaneous speech, he readily imitated, and the forms of his imitations were subject to strong constraints on the co-occurence of syllables within words. Specifically, the child favored words whose syllables were identical to each other or at least similar phonetically. The second section also documents the phonetic and phonological aspects of the child's acquisition of aspiration in syllable-initial stops and of the fricative system. (Author/NCR)

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TOPICS IN THE ACQUISITION OF MANDARIN PHONOLOGY: A CASE STUDY [1]

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Abstract

This is a longitudinal study of a child's acquisition of Mandarin phonology between the ages of 1;2 and 2;8.2. During this period, the child was, on the whole, much less verbal than many children reported in the child language literature.

The study consists of two parts. The first part is a description of the child's "proto-language," in which he used sound-meaning correspondences of his own invention for communicative purposes. It was found that both the segmental forms and the pitch contours of different "proto-words," or early vocables, correlated with their communicative functions. The description includes subsequent changes in the use of pitch, from being an expression of communicative intent during the period of proto-language to being a lexical feature of words after the child has begun to model his speech on the adult language.

The second part deals with the child's phonological development following the switch to words based on adult models. Although the child produced very little spontaneous speech, he readily imitated, and the forms of his imitations were subject to strong constraints on the co-occurrence of syllables within words: specifically, the child favored words whose syllables were identical to each other or at least similar phonetically. These constraints gradually relaxed over time. Finally, this section documents the phonetic and phonological aspects of the child's acquisition of aspiration in syllable-initial stops and of the fricative system.

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I. Introduction

This is a study of the phonetic and phonological development of one child, M, acquiring Mandarin, whose language development in general seems quite different from that of children in other studies. In comparison to other children, M spoke very little, even at the age of 2;8.2 when the study came to an end. During the first few years of his life, he met his communicative needs by means of gestures, vocalizations, and, after the age of about 18 months, single-word utterances. In communicating with those around him, he thus relied heavily on situations and contextual behavior and little on verbal expression.

A good illustration of this is a comparison between M's behavior and the behavior of P, another Mandarin-speaking child, in similar situations. P, when he was about 2;6, was trying one day to open a toy box but without success. He said to me, "Kāi bù kāi lē," ('it won't open') and then said, "Kāi kāi lē," [2] by which he was requesting me to open it for him. M, at the age of 2;5.2, was attempting to pry open a small paint box with his fingers, also unsuccessfully. When he saw me watching him, he immediately handed me the paint box without saying a word or uttering a sound. Clearly, the gesture alone within the context of the situation was a request that I open the box for him.

Shortly before his second birthday, M began to produce imitations regularly but in a restricted context: if one were to show him a picture of an object and name it, he would repeat the name. In general, however, he still did not imitate when the imitation was not "asked for" in this way.

Nevertheless, the forms of his imitations were quite revealing: 1) they show that he was capable of producing a much wider range of speech sounds than would have been evidenced by looking only at his spontaneous speech; 2) the forms of these imitations were subject to fairly strict constraints which seemed to operate on whole words as units, more specifically, they governed the combinability of syllables together to form words. These constraints gradually relaxed over time in a systematic and orderly way.

Despite the fact that more speech sounds occurred in M's imitated speech than in his spontaneous production, both types of speech appeared to be subject to the same general constraints, and when a change took place in the imitated speech, it would often show up in spontaneous speech as well. Since there is very little spontaneous production, however, the forms of the imitations allow us to view the changes over time in M's phonological system in much greater detail than would be possible in an examination of his spontaneous speech alone. The imitations thus seem to be like a "window" on one aspect of M's phonological competence,

namely, on what constituted for him, at any given stage, a phonologically permissible word.

This paper is therefore offered as a case study of one child's phonological development. It is what Ferguson has called a "linguistic profile," (1976:20) and it is hoped that it will contribute to our knowledge of the extent and nature of individual variation in normal language acquisition.

II. An outline of Mandarin phonology

1. Tones

Mandarin has four contrastive tones, as listed in Table I: high level, rising, low-dipping, and falling. The middle column of the table shows how the tones are represented in the pinyin romanization system, and the righthand column shows how they are represented by the 1-to-5 tone scale provided by Chao (1930), where 1, 3, and 5 correspond to low, mid, and high pitch, respectively. In addition, there is the so-called "neutral" tone which occurs on unstressed or very weakly stressed words: a certain number of particles, suffixes, and, frequently, the second syllable of bisyllabic words. The pitch of the neutral tone is determined by the tone of the preceding syllable, as shown in Table II (following Chao 1968:36).[3]

2. Syllable structure

The Mandarin syllable is traditionally analyzed as having three parts: 1) the initial, or first consonant, 2) the final, or all segments following the initial, and 3) the tone. (See Cheng 1973.) It is possible for a syllable to have no initial (syllables beginning with a vowel are referred to as having "zero initial"), but it must have at least a final and a tone. The only consonants permitted in syllable-final position are the dental and velar nasals.

3. Initials

The initial consonants of Mandarin are shown in Table III. Only a few of these, the pre-palatals and the retroflex, deserve comment.[4] The pre-palatal affricates and fricative (these are sometimes referred to simply as "palatals") are articulated with the tip of the tongue

TABLE I

Mandarin tones

Tones	Romanization	Tone scale
High level	mā	˥ 55
Rising	má	˧˥ 35
Low-dipping	mǎ	˨˩˦ 214
Falling	mà	˥˩ 51

TABLE II

Pitch of the neutral tone

After high level:	ˌ half-low
After rising:	· middle
After low-dipping:	ˈ half-high
After falling:	ˌ low

TABLE III

Mandarin initials

	Labials		Dentals		Pre-palatals		Retroflex	Velars	
	Unasp.	Asp.	Unasp.	Asp.	Unasp.	Asp.		Unasp.	Asp.
STOPS	p	p^h	t	t^h				k	k^h
AFFRICATES			c	c^h	tɕ	$tɕ^h$			
FRICATIVES	f		s		ɕ			h	
NASALS	m		n						
LIQUID			l						
CONTINUANT							ɻ		

right behind the upper front teeth and the blade of the tongue very close to the roof of the mouth just behind the alveolar ridge. The fricative /ɕ/ thus sounds quite similar to the fricative sound of the word ich in German but is articulated a bit more forward.

The retroflex consonant is made by curling the tip of the tongue back toward the center of the roof of the mouth. It thus sounds quite similar to the American English /r/ except that the tongue is pulled further back in the mouth.

4. Finals

The finals of Mandarin are presented in Table IV, which, except for a few differences, is very much like that found in Chao (1968:24). The following points need to be made:

1. The vowels /i/, /y/, and /u/ at the beginning of a final are onglides into the vowel nucleus, and the vowels /i/ and /u/ at the end of a final are diphthongal offglides. Thus, for example, the finals written here as /ia/ and /ua/ are phonetically identical to sequences that could be transcribed with IPA symbols as /ja/ and /wa/, respectively. The reason for not using the symbols /j/ and /w/, however, is that they are symbols for transcribing consonants, and since the finals have no consonantal initials by definition, the vowel symbols will be used. Similarly, the finals /uai/ and /iau/ sound identical to sequences transcribed as /wai/ and /jau/, respectively.

2. The symbols /ɿ, ʅ/ represent a high, central and unrounded vowel that occurs only after a retroflex initial or a dental affricate or fricative initial. They are allophones of a single phoneme, with /ʅ/ appearing after a retroflex and /ɿ/ following a dental. The sound is similar to that of /ɨ/ in IPA symbology.

III. Background

M was the second of two children in an exclusively Chinese-speaking family living in the San Francisco Bay Area. Both his parents are professionals in the business world, and neither speaks Mandarin as a native dialect although that is the dialect used in the home. His father speaks Shanghainese natively, and his mother's original dialect was Yǒngkāng (永康), a Wu dialect spoken in central Chekiang province. Over a period of roughly one year, M's paternal grandmother was living in the home, during which time he heard much Shanghainese, and both his father and grandmother occasionally addressed him in this dialect. M's older sis-

TABLE IV

Mandarin finals

Open ending	-i	-u	-n	-ŋ	-ɻ
ɿ ʅ ɤ a ɔ	ai ei	ɑu ou	an ən	ɑŋ ʌŋ oŋ	ɚ
i ia iɛ		iɑu iou	iɛn in	iɑŋ iŋ ioŋ	
u ua uɔ	uai uei		uan uən	uɑŋ uʌŋ	
y yɛ			yɛn yn		

ter, about four years older, is bilingual in English and Mandarin. She understands some Shanghainese but uses only Mandarin when talking in Chinese.

M is a normally active and curious child who, apart from speech production, exhibited no delay in developing physical and mental skills. When he concentrated on some kind of play activity, such as constructing a tower by piling blocks on top of each other or co-operating with someone in hammering wooden pegs into the holes of a toy board, he often had an idea as to how he wanted to complete the task and would stubbornly stick to it. In addition, he would never utter a sound while engaged in a task, unlike two other Mandarin-speaking children, P and J, who frequently sang to themselves or repeated rhymes when concentrating on something.

Whereas M related well with the members of his family and familiar friends, he was extremely shy with strangers and often took some time to become used to them. P and J, on the other hand, were generally more open to strangers at first.

The delay in M's spontaneous speech production and the systematicity of the phonological constraints on the forms of his words are both indications of the caution and orderliness with which he approached the language-learning task. This caution is also reflected in other areas of his personality such as those mentioned above: the structure and care he gave to the completion of a given task and his shyness with strangers.[5]

M's parents both attested that his older sister had been very verbal at an early age, and that she had exhibited no delay in the onset of speech. M's father, on the other hand, said that M was more like himself, i.e. he had also been very slow in acquiring speech.

M was seen over a period that lasted about 19 months, from when he was 1;2 until he was nearly 2;9. Visits were made once every two weeks and were generally from 1½ to 3 hours long. Much of the time was spent playing with games and toys, drawing pictures, reading books, etc. Sometimes, M's mother, grandmother, or sister would be present during the sessions.

IV. Early stages

1. Introduction

The purpose of this section is to give an account of M's speech during the eight-month period from 1;2 to 1;10, with particular emphasis on

the changing use of pitch. No data are available on M's babbling, and there was no evidence that he was still babbling at the age of 1;2. The period from 1;2 to 1;10 is a kind of transition period between babbling and the use of words based on adult models. During this time, M's speech consisted of various vocalizations of only a vowel with accompanying pitch and a few "words" which are more appropriately called "early vocables" in the sense defined by Ferguson (1976:9): consistent use on the part of the child of sound-meaning correspondences of the child's own invention and which have communicative function but are not modelled on actual adult words. This stage is therefore characterized as being one of "proto-language," also described by Halliday (1975), Menn (1976), and Tuaycharoen (1977).

The description is divided into two parts. The first part covers the period from 1;2 to 1;5.2 in which M's vocalizations seemed to be an expression of his emotional or affective state. Differences in affect were mainly signalled by different pitches. The second part goes from 1;5.2 to 1;10 during which time vocables still generally served to express affect but, in addition, other vocables appeared having referential function and with phonetically consistent pitches.

Following the second part is a brief description of M's use of pitch during the first few weeks after the end of this period, i.e. during the first weeks of his use of speech modelled on adult words. At this time, pitch served a lexical function: it was a feature of individual words.

2. Part I - 1;2 to 1;5.2

M's vocalizations during this period consisted almost exclusively of a single vowel, or perhaps a glide and a vowel, and an accompanying pitch. The vowels ranged in quality from high to low but were only front and central. No back vowels were produced at all. In addition, the high front unrounded vowel [i] was lacking. The vowels in his repertoire were therefore the following:

[ɪ ɨ ɛ eɪ ʌ ə æ a]

M made use of a variety of phonetically distinct pitches which fall into two main groups: 1) rising, high level, high and slightly rising, high and slightly falling, and mid level pitches were used if M wanted something or was eager to have something, or if he was having difficulty in doing something and needed someone else's help; frequently, these utterances were nasalized and produced with a whining quality. 2) Falling pitches, either going from high to low or from mid to low, were used to accompany an action that M had just performed, also if he had found or discovered something, or if he was simply content. Although the pitches

appeared to correlate with M's emotional states, there was no such correlation with the vowels, and any of them might be used with either kind of pitch.

Examples of the different uses for these pitches are the following:

1. M placed a sheet of paper on a box and said [jæ̀:, ʔæ̀][6] with high falling and low falling pitch, respectively, accompanying his action.

2. While trying to attach toy train cars together, M was unsure of himself and asked for help, uttering [ə̄ʔə̄ʔə̄:] with a high pitch. When the train cars were attached, he said [ɨ̀:] very contentedly and with high falling pitch.

3. Part II - 1;5.2 to 1;10

3.1. At the age of 1;5.2, M produced the utterance [ù:] when pretending to give water to a toy cow, said [u:][7] when being shown a toy horse, and also said [nù:, ù:, ù] when looking at birds outside the living room window. The difference between these utterances and those which M had produced up to this time is that these accompanied his seeing a particular object, or a member of a class of objects, rather than expressing an emotional or affective state. The utterances seemed to have a referent which was independent of both M and his listener. In addition, the vowel [u] of these utterances was new to his phonetic inventory: the first back vowel. Both the form and the function were therefore new. It was not a case of an old form being used for a new function.

At this time, M also began to repeat or imitate some utterances spoken by adults, but not in the "usual" sense of imitating or repeating, i.e. it was never clear that he was trying to produce the sound shape of a word he had just heard, and he did not seem to be repeating for a specifically communicative purpose such as confirming something said by an adult. Often, he would not even be looking at another person.

As an example, M was once lying on the floor with his head turned sideways and looking at a flat board. His mother was sitting next to him but outside his range of vision, and she was talking to him, saying [pʰə̄̌pʰə̄̌ŋ] (his nickname). Very softly, and without turning his head toward her, M said [pə̌:].

3.2. About a month later, at the age of 1;6.2, M abandoned this vocable and began producing a CVCV form to refer to all animals, birds, pictures of animals and birds, and some nonsense objects which were

small wooden blocks with faces painted on them. The form was [mùmù] with falling pitch on the second syllable or on both syllables (the first syllable had either high level or falling pitch). The quality of the vowel varied occasionally, however: sometimes it was shwa-like, and, once, even [a].[8]

From the age of 1;6.2 until 1;9, there are 21 recorded instances of this word. Of these, 10 are instances of M's touching, holding or picking up an animal or bird object; 7 instances involve his seeing or looking at such an object without acting upon it; on 2 occasions, M is showing an animal object to another person; and 2 times, he is reaching toward an object, trying to get hold of it. He never used this word in asking another person to give him something.

At this time, M's imitations of other people's gestures is noticeable, especially pointing to objects or to pictures in a book.

3.3. At the age of 1;7.2, about two months following the first appearance of a vocable with referential meaning, another one appeared but which had a more pragmatic function. Its form was VCV, [ɪnɪ], with both syllables equally stressed, and sometimes the initial syllable was a syllabic nasal. The vowels were often nasalized and produced with a whining quality, and the pitch was most often high level but sometimes high rising as well. Two weeks after the appearance of this vocable, its canonical shape became CVCV and was produced as [nẽ^{i}nɪ].

M used this vocable in asking someone to do something for him or if he was anxious or concerned about something. For example, if he wanted help in attaching train cars together, he would hold the cars up, knock them together, and produce the vocable. On another occasion, M was placing some nonsense objects on top of each other, and when it looked as though they were about to fall down, he nervously said [n̥:ɪ, ɪnɪ].

M's parents reported at this time that another word of his own invention was [jòjò], used consistently with falling pitch like [mùmù] and referring to plants, flowers, and trees. A few instances of this word are recorded but far fewer than the other vocable [mùmù].

In summary, there were three vocables in M's speech which had mutually exclusive pitch and segments and mutually exclusive communicative function. Two of these vocables had falling pitch and were used in a referential sense, i.e. pointing out an object without making a specific comment about it, and one vocable had high or rising pitch and was used to express worry or anxiety or to get another person to act on something.[9]

There was no evidence at this point that M had acquired what Menn refers to as "symbolic autonomy," (1976:42) or the concept that words

can be used to convey novel messages and for different kinds of speech acts such as reference, requests, etc. Each of M's vocables could be used for only one kind of communicative function. An illustration of this is an anecdote from when M was 1;7.2. He was pointing to an object outside of his reach and saying [ɪnɪ], clearly wanting me to give him something, but I couldn't tell what it was. Finally, he went himself to the object, which happened to be a toy cow, and, taking hold of it, said [mumumɪ̀].

3.4. At the age of 1;8.2, another vocable appeared of the segmental form [nono], and the nasal consonants were sometimes slightly palatalized and denasalized. The word seemed to mean something like "this thing," and M used it with falling pitch as he was flipping through the pages of a picture catalog, pointing at various things. On three occasions, however, he produced the word with high level or rising pitch on the second syllable, and each time he did so, he was looking either at his mother or at myself and was asking what something was. It was the first piece of evidence that words had "symbolic autonomy" for M, i.e. he was able to use a single word for different communicative purposes, either in a referential or in a questioning sense. The different functions were signalled by different pitches, so that pitch was used in much the same way by M during this session as by the English and American children reported in Halliday (1975) and Menn (1976), respectively, and by the Thai subject of Tuaycharoen (1977). It would appear that the use of pitch for differentiating social and communicative purposes is a strategy of children regardless of the use of pitch in the adult language, i.e. whether or not the language is tonal.

The vocable [nono] was very short-lived, however. It occurred only during a single session, and there are a total of six instances. Following this, there was a gap of six weeks where no recording was done due to family holidays. When visits to M's home resumed, he had begun to use words with adult models. The switch from early vocables to adult words occurred rather abruptly and very shortly after M had acquired the notion of symbolic autonomy mentioned earlier.

3.5. Mention should be made of a few other vocables in M's speech during this period. At the age of 1;8, M produced a few instances of monosyllabic words containing an initial stop and a back low vowel, but it was never quite clear what some of these vocables meant. For example, he said [gʌ̀, gʌ́] when reaching for a train car; on the other hand, when I pointed out a toy object to him and he took no interest, he said words like [nà], [dà], or [dɔ̀], making no other response. These vocables occurred during only one session.

At this time, the words [mūmù] and [nēˈnī] were being produced more frequently with three or sometimes four syllables: [nēˈnēˈnī] or [mumɪmɪ̀].

Finally, when he was 1;8.2, M produced six tokens of a vocable that varied in length from three to five syllables, had various pitches, i.e. might end in either rising or falling pitch, and had different vowel qualities. The consistent aspects of this vocable were that the consonants were always [n] or [d], and it was always uttered when M was reaching for an object, was excited upon seeing something, or appeared to be hoping for something, such as when he peered expectantly into the kitchen (he frequently looked in the kitchen for candy). The following are two examples of this vocable: [nˇndˆndˈɪˇ] and [nɛɒnōˈndʌ̄ᵘ].

It might seem at first as though this vocable is related to the one mentioned previously whose shape was [nono] and which appeared at exactly this time. This interpretation is doubtful, however, since [nono] was, in all its six instances, a bisyllabic word whose vowels were consistently of the same quality and whose pitch could clearly be correlated with communicative intent. The only similarity between [nono] and this other vocable is that they both contained alveolar consonants.

4. The beginnings of a tonal system

I would now like to go a bit beyond the age of 1;10, to briefly discuss the role of pitch in M's speech after he began to use adult words, and finally to summarize the changes in function that pitch underwent during these early stages of development.

At 1;10, the adult words that M produced were reduplicated nouns referring to animals and common objects such as fruit and cakes. He said the words either spontaneously or when an adult model immediately preceded his own utterance. All of the bisyllabic words that he produced spontaneously and for the purpose of referring to the object, had rising pitch. In this case, the reason for M's producing rising pitch so often is easily explained by its frequency in the adult language: M's parents produced rising tone words, low-dipping tone words, and a great many falling tone words all with the rising tone. High level tone words were reduplicated with their citation tone, but obviously the vast majority of words which M heard contained rising tone.[10]

At this point, it is not clear that M has a tonal system in any sense in which the adult language has tone. He does not exhibit any tonal distinctions that are phonological contrasts. Rather, he seems to have a "hypothesis" that words have rising pitch. Pitch at this stage is therefore not so much a means for differentiating communicative intent and is not simply a feature of an utterance in its entirety: pitch is now a feature of individual words.

M seems to recognize that other pitches are possible in addition to

the rising. When he was 1;10.2, he correctly imitated the word for 'duck' twice with high level pitch and the word for 'want' once with the correct falling pitch. However, the words for 'chicken' and 'cake,' which have high level tone, were imitated with rising pitch, and 'rabbit' was also imitated with rising pitch although the preceding adult model contained the falling tone.

At 1;11, M spontaneously produced 'chicken' with the correct high level tone on two occasions, and imitated 'pig,' 'cake,' and 'chicken' with the high level pitch. During the same session, M saw his grandmother folding clothes from the laundry and said [be^{1}bi], 'blanket,' (adult form: [pe^{1}pe^{1}]), with the correct falling pitch. At another point, he was taking crayons out of a box and said [ha^{1} jo], 'want more,' (adult form: [ha^{1} jau], also produced correctly with falling pitch.

It would seem, then, that by this age, M's hypothesis that words have rising pitch has weakened somewhat to allow other pitches as well. In addition, there is no evidence for an "order of acquisition" among the other pitches. Both the high level and falling pitches are beginning to appear at the same time. As for the low-dipping tone, M rarely, if ever, heard it from his parents in its full citation form in isolation, but when he imitated monosyllabic models which I produced with low-dipping tone, his imitations were always a mid-level pitch: a phonetically inaccurate imitation but still distinguished from either high level, rising, or falling pitches.[11]

At the age of 1;11.2, M spontaneously produced 'chicken' incorrectly with rising pitch and, on two occasions, said the word [jōjō] in reference to 'tree.' This had been a vocable which he had used earlier in reference to trees, plants, and flowers, but he had previously used only falling pitch on this word. Now, he was using the rising pitch. Although M had been making progress toward differentiating pitches from each other, it is clear that this process was gradual, and that his earlier notion that all words have rising pitch is still fairly strong.

Nevertheless, Ferguson & Farwell (1975) have pointed out that there is a problem in deciding whether or not a child has a phonological distinction between two given sounds if there are no examples of minimal pairs consistently made in the child's speech. Thus, in M's case, it is difficult to determine if he has a system of tones since there are no minimal pairs in his speech in which pitch is the distinctive feature. There is no evidence of a purely phonological contrast among pitches in such a way that we might conclude that M has a system of phonemic tones as does the adult language. It is certain, however, that pitch now has a lexical function, that it is a characteristic of individual words. The fact that words with rising pitch in adult speech are consistently rising pitch in M's speech, whereas adult high level tone words are variously produced by M with both high level and rising pitches is evidence that a distinc-

tion among pitches is beginning to be made, even if it is only at the lexical level.

5. Summary

The development during this early period can be summarized in five stages:

1. From 1;2 to 1;5.2, pitch serves to signal differences in mood or emotional state, rising or high pitch expressing worry, uneasiness, or questioning, and falling pitch being an expression of certainty or contentment. The vowel qualities of these utterances are inconsistent and do not correlate with pitch.

2. From 1;5.2 to 1;10, while utterances from the first stage are still being produced, a few vocables appear whose segments and pitches are phonetically consistent, and whose phonetic shape and communicative function are mutually exclusive. There is, however, no evidence that a vocable can serve for more than one kind of speech act, i.e. there is no evidence that words have symbolic autonomy for M.

3. A vocable appears which can function for more than one type of communicative act. Unlike the utterances of the first stage, the segments of this vocable are phonetically consistent. Differences in speech act are signalled by differences in pitch, and, in addition, the rising or high pitch is used by M to express questions about what something is, i.e. rather than expressing his own mood or affect, reference is made to some object independent of either M himself or his listener.

4. At about 1;10, there is a fairly abrupt switch from the use of early vocables of his own invention to the use of adult words in M's speech. Pitch at this point is lexical in the sense that it is a characteristic of words themselves as opposed to being an expression of mood or to being an inherent feature of a word that has only one communicative function. M has the hypothesis that words have rising pitch and applies it to one word which had previously been a vocable as well as to some adult words with high level or falling tone.

5. About one month after M begins using words with adult models, there appears the first sign of differentiation among pitches. Words with rising pitch in the adult language are consistently produced by M with rising pitch, whereas words with high level or falling tone are produced with both rising and their correct pitches. This last stage is evidence for a system of tones beginning to emerge, but it seems to be at the lexical level, and there is nothing as yet to indicate that M has a system of phonological tonal contrasts.

IV. Later stages

1. Word formations (1;10 to 2;5.0)

1.1. Constraints on the co-occurrence of syllables (1;10 to 2;3.1)

Shortly after the age of 1;10, when M had begun to use words with adult models, he began to imitate adult words, but in a very specific situation: if an adult held up an object or a picture of an object, showed it to M and said the name, M frequently imitated the word. All the words which he produced at this very early point were adult reduplicated nouns of the shape CVCV, where the consonant was either a stop or a nasal.

Although almost all the object-names M heard from his parents were reduplicated nouns, many words which I asked him to imitate were phonologically more complex, i.e. had two syllables that were phonetically dissimilar such as píngguǒ, 'apple,' instead of the reduplicated guǒguǒ, 'fruit.' It soon became evident from the forms of M's imitations that words containing dissimilar syllables (and thus a more complex phonological structure) were treated quite differently from those which were mere reduplications. It seemed in fact as though M had a strong preference for either one-syllable words or for polysyllabic words where all the syllables were alike in their sound structure.

When confronted with a word whose syllables were phonetically unalike, M made use of one of two strategies: 1) his imitation was monosyllabic, i.e. one of the syllables in the adult model was simply "deleted" or disposed of, and 2) the imitated form contained both syllables, but they were made much more alike phonetically. Each of these strategies will now be discussed and exemplified:

1. In making an imitated form with only a single syllable, the second syllable of the adult word was, in almost all cases, the one to be preserved. For example, the adult form [tɕʰɪ̃ŋwa], 'frog,' was imitated as [jɪ̃]. From the age of 2;1 to 2;5.2, M made use of this strategy on 41 occasions, and on 36 of these, he preserved the second syllable. This may be because the final syllable tends to receive heavier stress in Mandarin, although differences in stress frequently become minimized in baby talk.

On the other hand, if the bisyllabic adult word contained the noun suffix -zi as the second syllable (phonetically [cɿ], a voiceless unaspirated dental affricate followed by a high central unrounded vowel,

sometimes described also as a syllabic consonant), the initial syllable of the adult word would be preserved.[12] In these words, the adult language stresses the initial syllable more than the second. During the period between 2;1 and 2;5.2, M used his "syllable-dropping strategy" for such words in 29 different instances, and in all of them, the initial syllable was preserved in his imitation, whereas the suffix -zi was dropped.

2. To illustrate the second strategy, Table V gives examples of M's imitated forms which contained the same number of syllables as the stimulus he heard, but where the syllables are much more alike phonetically than in the model.[13] In the case of some words, such as shànzi and shéngzi, he seems to have simply made a reduplication of the first syllable.

Both of these strategies are examples of a phenomenon called "word-shaping strategies" (Ferguson, personal communication; see also Ferguson 1976:11-12, 18-22) and seem to reveal what constitutes a phonologically permissible form from the point of view of the child's production at a given stage.

Although M preferred words whose syllables were as alike as possible, he did make a few allowances. He permitted two-syllable words in which the syllable-initial consonants differed in manner of articulation (such as [bãmã] from adult [bãŋmãŋ] 'help'), and he also permitted words in which the consonants differed in place of articulation (for instance, he once imitated the word [máutɕin], 'towel,' as [mɔ̄ɪ̄nɪ]. But he did not allow words to be formed in which the consonants differed in both these dimensions. In addition, he seems to have preferred that both or neither of the syllables in a bisyllabic word end in a nasal consonant or at least a nasal vowel.

Glides and /h/, on the other hand, appeared to occur in words quite freely both with each other as well as with other consonants, as in [hāí jò], 'want more,' (adult form: [hái jàu]). Furthermore, there was no striking evidence for an avoidance strategy on M's part toward words in the adult language which contained a particular sound or class of sounds. He would attempt to replicate any kind of word, but the consonant inventory of his own output was restricted to stops, nasals, glides, and /h/.

The forms of M's productions are therefore not constrained in terms of segment-type or what kinds of segments can combine together to form syllables, but rather the constraints have to do with the types of syllables that can combine to form whole words. His phonological system at this time is structured on these two units.

One more example will serve as an illustration of the difficulty M

TABLE V

Illustrations of M's second word-shaping strategy

	Pinyin	Meaning	Model token	M's phonetic form
1.	píngguǒ	'apple'	[$p^{h}\widetilde{\text{ɪ}}ŋk^{u}\bar{ɔ}$]	[$\bar{\text{k}}a\bar{ŋ}w\bar{ɔ}^{n}$]
2.	lǎohǔ	'tiger'	[$\widetilde{\text{lauhū}}$]	[$\widetilde{ɔ}j\bar{ɔ}$]
3.	máojīn	'towel'	[$\widetilde{\text{mau}}\bar{\text{tɕ}}\bar{\text{ɪ}}\text{n}$]	[$\bar{\text{m}}\text{a}^{u}\bar{\text{m}}\text{əi}$]
4.	dòuzī	'bean'	[tòcī]	[tò:jò]
5.	shànzī	'fan'	[sǎncī]	[$\widetilde{\text{tan}}$tàŋ]
6.	shéngzī	'rope'	[$\widetilde{\text{sə̄}}$ŋcī]	a) [$\bar{\text{t}}\text{æ}^{n}\bar{\text{t}}\text{ɪ}^{n}$]
				b) [$\widetilde{\text{tæ:n}}$:ɪn]

experienced in trying to combine two phonetically dissimilar syllables together. In attempting the adult word [kua $n^{i}\acute{o}$], 'snail,' he said the first syllable [$k^{u}a$], then suddenly stopped short and said very softly, [kənə], almost as though he could say the first syllable perfectly but tripped over the rest of the word. There was no question that he was capable of producing a version of the adult sounds of the second syllable: in the same session, he produced [$n\acute{\Lambda}n\grave{\Lambda}$] for [$n^{i}\acute{o}n^{i}\acute{o}$], 'cow,' and also said [$n\acute{\varepsilon}n\acute{a}^{u}$] for [$n^{i}\acute{a}un^{i}\acute{a}u$], 'bird.'

1.2. Developing trends: relaxation of the constraints (2;3.1 to 2;5.0)

The two word-shaping strategies described in the previous section operate in M's production up until the age of 2;5.2, approximately. However, at the age of 2;3.1, he begins relaxing his constraint against the combination of phonetically dissimilar syllables by allowing words to consist of a more complex phonological structure, i.e. by letting them contain syllables unlike each other. The change is by no means sudden, and M uses two means to achieve the combination of dissimilar syllables:

1. He produces both syllables of a given word but with a pause between them instead of one right after the other. Interestingly, this strategy is precisely one that was used by a child acquiring Spanish as a first language, as reported by Macken (1976:42), who referred to this phenomenon of separating unlike syllables as "temporal spacing."

2. For words whose second syllable is the suffix -zi, M produces the syllable [$t^{h}\ddot{+}$] containing an initial aspirated stop followed by a voiceless vowel.[14]

Both of these strategies are illustrated in Table VI.[15]

Further evidence for the change occurring at this time in M's phonology comes from occasions when he was asked twice in a row to imitate the same word: on the first imitation, he replicated the initial syllable, while on the second, he imitated the second syllable. For the adult word [$s\bar{o}p^{h}\grave{a}$], 'handkerchief,' for example, M said [tō]; when asked to say it again, he said [pā]. Similarly, with the word [$y\acute{s}\bar{a}n$], 'umbrella,' M said [$\acute{y}^{h}$] at first, but, when asked to repeat the word, he then said [tā]. Following this, very quietly and to himself, he said [$\acute{y}$ .. $t\bar{a}$].

An interesting illustration of the changes in M's phonological system is his imitations across time for the word [$m\acute{a}ut\phi in$], 'towel.' The first imitation, at the age of 2;1, was [$m\bar{\jmath}^{I}n\bar{\imath}$], a CVCV form in which the initial consonants of each syllable were made much more alike, differing in place of articulation but at least agreeing in manner. At

TABLE VI

Illustrations of M's use of temporal spacing and the addition of the suffix -zi

	Pinyin	Meaning	Model token		M's phonetic form
1.	caǒméi	'strawberry'	[$c^h\bar{a}\bar{u}\acute{m}\acute{e}\acute{i}$]		[$t\acute{a}^{u}$ .. $\acute{w}\acute{e}^{i}$]
2.	dàyú	'big fish'	[tà ý]		[tà .. $\acute{e}\acute{w}$]
3.	guāniú	'snail'	[$k^{u}\bar{a}n^{i}\acute{o}$]	a)	[$k^{u}\bar{\wedge}$ .. $n\acute{i}\acute{o}$]
				b)	[$\bar{k}a\bar{k}\bar{o}$:]
4.	yèzi	'leaf'	[jècī]		[$\bar{t}\imath$ .. $\bar{t}\imath^{h}$ .. $\bar{\imath}^{h}$ .. $\bar{\imath}^{h}$ .. $\bar{\imath}t^{h}$ .. $\bar{\imath}t^{h}$ .. $j\grave{\varepsilon}^{\grave{\imath}}$:ɕ]
5.	dòuzi	'bean'	[tòcī]		[tò:$t\bar{\imath}$]
6.	xiùzi	'sleeve'	[ɕiòcī]		[tɔ̀t^{h}]
7.	tùzi	'rabbit'	[$t^{h}\grave{u}c\bar{\imath}$]		[$t^{i}\grave{u}t^{h}$]
8.	shànzi	'fan'	[sǎncī]		[$t\grave{a}^{h}t\imath$]

2;1.2, he produced two more CVCV imitations: [mə̄ʊm:ə̄ˈ] and [mǣwˈ̄], and, at 2;2.1, he said [mə̄ˈT̄]. At the age of 2;3.3, just as he was beginning to combine phonetically distinct syllables together into words, M produced the form [mə̄ .. tintin] with a pause between the initial syllable and the reduplicated second syllable. In that same session, when he was again asked to imitate this word, he said [mʌ̄ ..ⁿ.. tin], with a slight trace of a nasal segment at the end of the first syllable. I then repeated his own form back to him, saying [mʌ̄ntin] with nasals at the end of each syllable, and M excitedly responded [mʌn::tɕin::] with very long nasal segments in each syllable. Although M was willing to combine two syllables with different initials, he exhibited a strong preference for them to be alike in at least one respect: focus now switched to the final segment.

When he was 2;4.1, M produced the first token of this word in which both syllables were uttered without an intervening pause, and in which only the second syllable contained a final nasal. Preference for nasals in each syllable persisted for some time after this, however, and was expressed by nasalization of the vowel or by the presence of a slight nasal segment in the initial syllable. Even at 2;7.2, M produced an imitation containing very clear nasal segments in both syllables.[16]

The different forms which he produced across time for [maʊtɕ̄in] are listed in Table VII.

It is at the age of 2;5.0 that M first produced a number of forms containing phonetically dissimilar syllables with no intervening pauses. This strategy of temporal spacing was still being used at this age but became considerably less frequent by 2;5.2 and was extremely rare after the age of 2;6.0.

2. Aspiration (2;3.1 to 2;7.0)

As is shown in Table III, the adult language makes a distinction between two kinds of voiceless stops, aspirated and unaspirated. This section of the case study is a description of M's gradual acquisition of this distinction in his production: it took approximately four months, from the very first point at which he consistently produced aspirated stops in one environment to the time at which he had control over the distinction in all positions, i.e. in monosyllabic words and in either the first, second, or both syllables of bisyllabic words.

Aspiration first appeared, as was mentioned in the preceding section, at the age of 2;3.1, as part of a strategy for allowing the combination of phonetically unalike syllables into the same word. Only M's rendition of the adult suffix -zi contained an aspirated stop, and it always pre-

TABLE VII

M's forms for the word [máutɕɪ̄n] , 'towel,' across time

Age	Form
2;1.0	[mɔ̄ɪ̄nɪ̄]
2;1.2	[mā^{u}mə̄ɪ̄]
"	[mǣwɪ̄]
2;2.1	[mə̄^{i}ɪ̄]
2;3.3	[mā .. tɪ̄ntɪ̄n]
"	[mʌ̄ .. ^{n} .. tɪ̄n]
"	[mʌ̄n::tɕɪ̄n::]*
2;4.1	[mʌ̄^{t}tɪ̄n]
2;5.0	[pɪ̄^{n}t^{h}ɪ̄:n]
2;5.2	[mʌ̄tɪ̄^{n}]
"	[mɪ̄t^{h}ɪ̄:^{n}]
"	[mʌ̄tɪ̄n]
2;6.0	[mə̄^{n}tɪ̄n]
"	[mə̄tɪ̄n:]
2;7.0	[mə̄ntɪ̄n]
2;7.2	[mə̄ntɪ̄n]
"	[mə̄ntɪ̄n]

*This particular form was M's response to my imitation of his form.

ceded a voiceless vowel. Aspiration was absent from all other environments.

A month later, at 2;4.1, M produced very slight aspiration on the initial stops of six monosyllabic words (these were all the monosyllabic words in this session for which aspirated initials would have been "correct": the adult forms for two of these words contained stops, and the rest were fricatives and aspirated affricates, which M produced as homorganic stops).

On the other hand, there were six bisyllabic words in that very session which M might have produced correctly with aspirated initials in the first syllables but didn't. In addition, fourteen bisyllabic words were imitated that have aspiration in both syllables of the model, but only three of M's imitations of these had aspiration. M clearly had a preference for dealing first with the shortest possible word in acquiring the new distinction. (cf. Waterson, to appear)

During the first month or so of this development, aspirated stops were sometimes not like their adult models phonetically. There was occasionally a delay between the plosion and the voicing but no "aspiration" in the sense in which it has been traditionally defined, i.e. as a "puff of air" accompanying release of the stop. In this case, the release of the stop was followed by a slight pause which was followed in turn by the vowel. M thus appeared to be using temporal spacing for a second purpose: approximating the delay in voicing onset in the adult language.

At the age of 2;5.0, model bisyllabic words with aspirated initials in the first or in both syllables were produced with correct aspiration in only about half the instances (7 out of 13). Stops in monosyllables, however, and also in the second syllable of bisyllabic words, were almost uniformly produced with the correct aspiration.[17]

At this point, then, aspiration was controlled in the last syllable of the utterance, regardless of whether it was monosyllabic or bisyllabic. It is possible that M's preference for aspirating the stops of second syllables as opposed to the first syllables of bisyllabic words is related to the fact discussed earlier that second syllables tended to be preserved in those imitations when M used a syllable-deleting strategy in order to avoid bisyllabic words with phonetically dissimilar syllables. Since M had tended earlier to preserve the final syllable in imitated forms, it is reasonable to suppose that he might use that position for acquiring a new phonological contrast later.

In fact, M occasionally aspirated stops in the second syllables of bisyllabic words even if they were not aspirated in the adult models. (During the session at age 2;5.0, M produced 34 tokens of words of this kind, and of these, 14, or roughly 40%, had aspirated second-syllable stops.) Table VIII shows examples of different kinds of bisyllabic words

TABLE VIII

Illustrations of M's use of aspiration in bisyllabic words at age 2;5.0

Pinyin	Meaning	Model token	M's phonetic form
táng	'candy'	[$t^{h}\bar{a}\eta t^{h}\acute{a}\eta$]	[$t\bar{a}\eta t^{h}\acute{a}\eta$]
pídài	'belt'	[$p^{h}\acute{i}t\grave{a}i$]	[$\bar{p}it^{h}\grave{a}i$]
xiāngjiāo	'banana'	[$ɕ^{i}\bar{a}\eta tɕ^{i}\bar{a}u$]	[$\bar{t}at^{h}\bar{a}:^{u}$]
jiǎndāo	'scissors'	[$tɕ^{i}\bar{ɛ}t\bar{a}^{u}$]	[$t\bar{ɪ}\eta t^{h}\bar{a}:^{u}$]
diànguāng	'lightning'	[$t^{i}\grave{ɛ}k^{u}\bar{a}\eta$]	[$k^{u}\bar{a}\eta t^{h}\bar{a}:\eta$]
máojīn	'towel'	[$m\acute{a}ut\bar{ɕ}\bar{ɪ}n$]	[$p\acute{\bar{ʌ}}^{n}t^{h}\bar{ɪ}:n$]
húdié	'butterfly'	[$h\acute{u}t^{i}\acute{ɛ}$]	[$\bar{h}u$ .. $t^{h}\bar{ɪ}:$]
gēzǐ	'pigeon'	[$k\bar{ə}c\bar{ɪ}$]	[$k\bar{ə}t^{h}\bar{ɪ}$]
màozǐ	'hat'	[$m\grave{a}uc\bar{ɪ}$]	[$m\grave{a}^{u}t^{h}\bar{ɪ}$]
qúnzǐ	'skirt'	[$tɕ^{h}\acute{y}nc\bar{ɪ}$]	[$\acute{\bar{ɳ}}d\acute{ɪ}\eta t^{h}\bar{ɪ}$]

and how M dealt with the aspiration in them at this time: the word for 'candy' is a simple reduplication, the words for 'belt' and 'banana' contain aspirated initials only in the first syllable (M's regular substitute for adult [ɕ] as in 'banana' was [t^h]), the next four words contain no aspirated stops at all, and the remaining examples are words with the -zi suffix, which M now produces with both an aspirated stop and a voiced vowel.

This "overgeneralization," or tendency to aspirate the stops of final syllables that are not even aspirated in the adult model, persists in at least a couple of words for another month until the age of 2;6.0. At that time, M produced four tokens of 'belt,' [p^hítài], with aspiration only on the second stop, and, similarly, produced two tokens of the phrase 'sing a song,' [c^hân kə], with aspiration in the final syllable only. After this point, however, this phenomenon no longer occurred.

Meanwhile, at 2;5.2, M begins to aspirate the stops of initial syllables. For example, two tokens of the phrase 'it is raining,' [ɕìa y̆], contain aspirated stops initially ([t^hà jú]), and M fluctuates with the word [p^hút^{h}áu], 'grape,' which has aspirated stops in both syllables: it is imitated once as [t^hɪəpáu] with aspiration in the first syllable but then also as [tip^{h}áu] with aspiration in the second syllable only.

Aspiration in the first of a two-syllable word is well controlled by the age of 2;7.0, and after this point, it is extremely rare to find instances in M's speech of adult aspirated stops being left unaspirated or adult unaspirated stops being aspirated.

To summarize, the aspirated vs. unaspirated stop distinction first develops in monosyllables and in the second syllable of bisyllabic words: during this period, M used an aspirated stop followed by a voiceless vowel as one means for achieving the combination of phonetically dissimilar syllables into a single word. Later, the aspirated stop was followed by a voiced vowel in this environment, and aspiration began to appear in monosyllables and in the second syllable of two-syllable words. The last position in which the distinction was controlled was in the first syllable of two-syllable words.

3. Fricatives (2;5.2 to 2;8.2)

The last topic to be covered in this case study is the development of fricatives during the three-month period from when M was 2;5.2 to when he was 2;8.2. I will be concerned with the labiodental /f/, the alveolar /s/, and the pre-palatal /ɕ/. In addition, the development of /h^u/ will also be examined since M's substitutions for this sound were for a while very similar to those for the other three, although, strictly speaking,

/h^{u}/ might not be considered a fricative since it has much less friction than the others.[18]

Until the age of 2;5.2, the fricatives in adult models had been substituted with more or less homorganic stops, so that /s/ and /ɕ/ were rendered as [t] or as [t^{h}]. On the other hand, there were very few words which M produced that contained /f/ in their adult forms: at 2;5.0, the word féizào [fé^{i}càu], 'soap,' was imitated as [pípà:^{u}] and as [pítà:^{u}]; at 2;4.1, the word fānqié [fāntɕ^{h}iɛ́], 'tomato,' was imitated as [ɹʌwʌtɪ̄] and as [h^{u}ɪ̄ .. jā .. kɪ̄]. A third word was fēijī [fe^{i}tɕi], 'airplane,' and it was treated differently, perhaps because it was frequently produced spontaneously. Its form in M's speech was most often something like [wʌtɪ ~ ʌtɪ ~ ɔtɪ] or perhaps the three-syllable [tàwʌtɪ] from the adult model dà feiji, 'big plane.'

At 2;5.2, M produced a total of 29 instances of /f/, /s/, and /ɕ/, of which 15 tokens were stops, and the rest were fricatives: [h], or, for adult /ɕ/, either [h] or [ɕ]. Two weeks later, at 2;6.0, he produced a total of 46 tokens of these three fricatives, out of which only five were stops. The most common substitute for all three of these fricatives was [h], which was also frequently produced for adult /h^{u}/.

The differentiation of fricatives from stops was thus accomplished fairly rapidly, over a period of a couple of weeks, and all the fricatives underwent this differentiation at the same time. There was, however, very little distinction among these different fricatives at first.

Table IX displays the phonetic forms which M produced for the four sounds /f/, /s/, /ɕ/, and /h^{u}/ during the period from 2;5.2 to 2;8.2. Three phonetic symbols in this table need explaining: 1) [h^{i}] symbolizes a palatalized [h] which is quite close to the adult pre-palatal [ɕ] but has less friction; 2) [β̞] is taken from the transcription system of Bush et al. (1973), developed especially for the transcription of children's speech, and symbolizes a voiced labiodental spirant produced with a very slight degree of friction; 3) ["f"] symbolizes the child's successful approximation of the labiodental place of articulation but total lack of friction. Finally, the number in parentheses under each phonetic symbol indicates the number of tokens of that phone for a given session.

The data in Table IX make clear two distinct lines of development among these four sounds:

1. From the age of 2;6.0 onwards, the two fricatives /s/ and /ɕ/ are at least partially distinguished from the other two by often being rendered in M's speech as the phone [h^{i}]. By 2;8.0, /s/ and /ɕ/ are almost fully distinguished from /f/ and /h^{u}/, but they never contrast with each other. Furthermore, M manages to achieve a fairly adult-like production of the adult phone [ɕ] but never produces the adult phonetic

TABLE IX

Fricatives in M's speech

Age	/f/	/s/	/ɕ/	/h^u/
2;5.2	$[p]_1$ $[h]_1$ $[p^h]_1$	$[h]_4$ $[t^h]_4$	$[ɕ]_6$ $[t^h]_5$ $[h]_3$ $[t]_3$ $[p]_1$	$[h]_5$ $[j]_1$
2;6.0	$[h]_3$ $[ɸ]_2$ $[w]_1$ $[x]_1$	$[h]_9$ $[h^i]_4$ $[t^h]_1$ $[x]_1$	$[h]_{15}$ $[t]_4$ $[h^i]_2$ $[w]_1$ $[ɕ]_1$ $[j]_1$	$[h]_6$ $[w]_2$
2;7.0	$[h]_4$ $[\text{"f"}]_1$	$[h^i]_5$ $[h]_5$ $[θ]_3$ $[t^h]_1$ $[tθ]_1$ $[t]_1$ $[j]_1$	$[h]_4$ $[h^i]_1$	$[h]_4$ $[h^u]_4$

TABLE IX (continued)

Fricatives in M's speech

Age	/f/	/s/	/ç/	/h^u/
2;7.2	$[h]_5$ $[\Phi]_2$ $[\text{"f"}]_1$ $[p^h]_1$	$[h^i]_4$ $[h]_3$ $[t]_1$ $[\chi^h]_1$ $[\Phi]_1$ $[c^h]_1$ $[j]_1$ $[\theta]_1$	$[ç]_3$ $[t^h]_3$ $[h]_2$ $[h^i]_2$	$[h^u]_2$ $[h]_2$ $[\beta_{\downarrow}]_2$ $[\Phi]_2$
2;8.0	$[\text{"f"}]_2$ $[h]_2$ $[pf]_1$ $[f]_1$ $[h^u]_1$	$[h^i]_4$ $[t^h]_2$	$[ç]_2$ $[h^i]_2$ $[h]_1$ $[t]_1$	$[h^u]_3$ $[h]_1$
2;8.2	$[h]_1$ $[\beta_{\downarrow}]_1$	$[h^i]_7$ $[\theta]_1$	$[h^i]_7$ $[ç]_2$	$[h^u]_1$

values of [s].

2. From 2;6.0 onwards, /f/ and /h^{u}/ appear to be quite like each other in M's speech and therefore perhaps not distinct. Especially in the session at age 2;7.2, these two sounds are rendered by very similar phones, some having labial while others having velar qualities.[19] Because of a lack of data, however, it is never clear whether or not these sounds are distinguished by the age of 2;8.2. One minimal distinction, at least, between the two is that occasionally, M produced imitations of adult [f] in which one could see clearly that he achieved the labiodental point of articulation but produced no friction. He would then release the closure very gently, with no plosion, and produce the remaining segments of the word normally. What preceded the first vowel, therefore, was simply silence.

In summary, M's acquisition of the fricatives was incomplete at the time he was 2;8.2. Although the fricatives all became differentiated from the stops at the same time, they were still not entirely distinct from each other three months later. There appear to be two main contrastive groups: on the one hand are /s/ and /ʂ/, which M does not distinguish in his production, and on the other are /f/ and /h^{u}/ which seem to be partially contrasted with each other. In addition, M achieves the adult phonetic values of only two of these fricatives during the period of study: /ʂ/ and /h^{u}/.

4. Summary

During these first early years, M exhibited a very slow development in his use of speech as a communicative tool. Despite the fairly large number of imitated forms that could be obtained, the use that he made of spontaneous speech was very minimal in comparison to many children whose speech acquisition has been reported in the literature. The slowness of M's linguistic development reflects, I believe, a caution in his approach to the language-learning task which results in the systematicity of his phonology. There was, however, no strong evidence for an "avoidance strategy" on M's part toward any particular sound or class of sounds. This might well be due to individual differences between M and other children who do exhibit such strategies: while one child may refuse to even attempt an adult word containing a specific sound, another child, like M, may attempt to say the word but would constrain the phonological form of his production to be in accordance with the demands of his own system. An example of this in M's own development is his strategy of making two dissimilar syllables in the same word as alike as possible.

An interesting aspect of M's imitated forms and the changes that they undergo across time is that they are really the only means for ob-

serving the structure of his phonological system: they provide evidence for developmental changes which were happening despite the very limited amount of spontaneous speech output.

Some developmental trends in M's speech were extremely gradual, such as the control he gained over the distinction between unaspirated and aspirated stops, an acquisition which took roughly four months to complete. Similarly, M at first had strategies for dealing with words with two phonetically dissimilar syllables, either making the syllables more alike or deleting one; despite the fact that he later began to combine unalike syllables into the same word, these two original strategies were still operative to at least some degree for some time. There was therefore a great overlap in time between the strategies he used for constraining the forms of words and the strategies he used for allowing words with a more complex phonological structure.

By comparison to these, other changes appeared to take place more quickly, such as when M switched from using early vocables of his own invention to using words based on adult models with very little overlap. This change took place within six weeks.[20] Another example is the change from substituting stops for fricatives to producing some kind of fricative for all fricatives; this change took only four weeks or so to occur.

At the beginning of M's use of adult words, the units on which his phonology was structured were the syllable and the word. Later changes, however, such as the development of distinctive aspirated vs. unaspirated stops and the differentiation of fricatives from stops are evidence for the reality of segments as a part of his phonological system.

Footnotes

1. This article is a chapter from a doctoral dissertation written at the University of California, Berkeley. I wish to thank the following people for their comments: Susan Ervin-Tripp, John Ohala, Karl Zimmer, Charles Ferguson, Lise Menn, Marilyn Vihman, and the members of the Stanford University Child Phonology Project, Marlys Macken and David Barton. Most of all, I wish to express my gratitude to M and to his family.

2. The romanization system used throughout this article is pinyin. Words spelled in pinyin are underlined.

3. This is not the complete picture of the Mandarin tonal system. There are, in addition to the tones themselves, rules which change the phonetic shapes of the tones in certain environments. These are not relevant to the content of this paper, however.

4. Table III does not include three retroflex initials found in Peking Mandarin: the aspirated and unaspirated affricates and the voiceless fricative. These sounds do not exist in the speech of M's parents, and words containing either a dental or a retroflex affricate or fricative in the Peking dialect are all pronounced with dentals by M's parents.

5. Other studies, such as Macken (1976) and Vihman (1976), have attempted to link phonological development with aspects of a child's personality.

6. I am using the following symbols for transcribing the pitches of M's speech (due to space limitations, the differences among these symbols are less clear in the text than in the tables):

   (V = vowel)

1.	$\underline{\bar{V}}$	Low level
2.	V	High level
3.	$\bar{V}$	Mid level
4.	$\grave{V}$	High-to-low falling
5.	$\acute{V}$	High-to-mid falling
6.	$\grave{V}$	Mid-to-low falling
7.	$\check{V}$	Low rising

8.	V̋	High rising
9.	V́	Mid-to-high rising
10.	V̏	Low-dipping

The symbol [V:] signifies a long vowel, and [n̩] denotes a syllabic nasal.

7. The pitch of this token was not recorded.

8. It may be the case, of course, that M did not "abandon" the earlier form and substitute a new one, but that the newer one grew out of the original one.

9. The origin of the particular pitches that M used for different communicative purposes is problematic. In the adult language, utterances expressing anxiety are generally produced with a higher pitch key over the utterance as a whole, while the basic tone contours of the individual words are maintained; on the other hand, simple requests for help in doing something are not necessarily uttered with a general raised pitch. As for the source of the falling pitch of M's more declarative [mù̀mù̀], ordinary statements in the adult language are characterized by a trailing off of the pitch to a lower key at the end of a long sentence, but for a short sentence of three or four syllables, there is no such pitch key modification (Chao 1968:40; see also Chao 1933).

10. The parents of M, P, and J (three separate families) differed from each other to some degree in the tones they used on reduplicated nouns. P's parents, speakers of "standard" Mandarin but not from Peking, reduplicated low-dipping tone words using a tone-changing rule by which the first syllable of the reduplication bore the rising tone, and the second had a low-dipping, or, more often, a low-level tone. In addition, however, a large number of falling tone words were reduplicated with the rising tone, such as the words for 'rice,' 'bean,' 'egg,' 'medicine,' 'tummy,' and 'sleep.' J's parents on the other hand, who spoke Peking Mandarin, used the tone-changing rule in reduplicating low-dipping tone words but, unlike P's parents, used falling tone in reduplicating falling tone words.

	Pinyin	Meaning	Parental form
P's parents:	mǎ	'horse'	[mámā]
	dàn	'egg'	[tā̂ntā̂n]
	shuìjiào	'sleep'	[sùei tɕiāu tɕiāu]

	Pinyin	Meaning	Parental form
J's parents:			
	mǎ	'horse'	[mámā]
	dàn	'egg'	[tǎntǎn]

11. On several occasions, I asked M's older sister to give me the Chinese word for objects whose names bear the low-dipping tone, and she responded with monosyllables with the full low-dipping citation form. It seems likely, then, that her parents' input changed, as she had become older, from using reduplicated nouns with the rising tone to using monosyllables with the low-dipping citation form.

12. This suffix is very frequent in Mandarin, but its use is not governed by a rule: one simply has to learn which words can take the suffix and which cannot. It is often dropped in parental speech to children where a noun is reduplicated instead, so that a child hears [jāja], not [jācī], 'duck.'

13. In Table V, the forms in the column labelled "Model token" are the forms spoken right before M's imitations.

14. Aspirated stops are distinctive in Mandarin, but the affricate in the model -zi is not aspirated, and M produces aspirated stops nowhere else at this time.

15. An additional and very minor process was a kind of consonant harmony for words ending in -zi, in which M imitated only the first syllable but then placed the initial consonant of the syllable at the end of it as well, so that the adult word [kʰùcī], 'pants,' was produced as [kūk], and [màucī], 'hat,' was produced as [màm] or as [màp]. These forms indicate that M was cognizant of more than just the first syllable in the adult model but was still not able to complicate too much by accurately imitating the second syllable as well.

16. M's persistence in placing nasals in each syllable for such a long time was specific to this word. From the age of 2;5.0 onwards, he produced a number of other words with one open syllable and one nasal-final syllable, as in the adult models. Before the age of 2;5.0, however, the development of máojīn was more typical of his phonology.

17. The previous session, at age 2;4.1, happened to have no instances of bisyllabic words in which the second syllable is aspirated. It is possible that aspiration developed in this position at the same time as it did in monosyllables.

18. /hᵘ/ is not one of the initials included in Table III, "Mandarin

initials." The sound [h^u] is produced when the initial /h/ precedes a final beginning with the onglide /u/, as in huǒ [$h^u\tilde{o}$], 'fire,' or huā [$h^u\bar{a}$], 'flower.'

19. The child J, from at least the age of 1;10 until she was about 2;10, consistently substituted either [f] or the labiodental fricative [ɸ] for the adult [h^u].

20. Of course, the change may have been gradual during the six-week period when no visits were made to M's home, but it was the case that the change had not begun at the beginning of this period and had been completed by the end of it.

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